SEGREGATION OF *HASTINGSIA SERPENTINICOLA*, SP. NOV. FROM *HASTINGSIA ALBA* (LILIACEAE: ASPHODELEAE)

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ABSTRACT

A new taxon, *Hastingsia serpentinicola,* is segregated from *Hastingsia alba.* The range of *Hastingsia serpentinicola* is sympatric with that of *H. alba* except for the northern Sierra Nevada where no *H. serpentinicola* has been found. *Hastingsia serpentinicola* is exclusively limited to serpentine soils. It occupies dry open hillsides and does not occur within the permanently wet, boggy habitats of *H. alba.* There is no evidence of hybridization. The segregation of *Hastingsia serpentinicola* necessitated an emended description of *H. alba.*

A systematic study of *Hastingsia* of the Klamath Mountains of Northern California (Becking et al. 1982; Becking 1986) has revealed the existence of a new species herein described.

Hastingsia serpentinicola Becking, sp. nov.—TYPE: USA, Oregon, Josephine Co., Cave Junction, Eight Dollar Mt. BLM *Darlingtonia* bog, 450 m, T38S R8W sect. 28 SW¼ of SW¼, long. 123°39′25″W, lat. 42°14′00″N, 28 May 1985, *R. Becking 850500* (holotype, CAS; isotypes, GH, HSC, OSC, UC, US).

Herba typice inferioris. Bulbus oblongatus, frequenter attenuatus, 23–40 mm longus, 14–21 mm diametro. Scapus unus per annuum, 28.6–51.4 cm altus. Folia angusta, linearia, 19.6–34.5 cm longitudinis maximae et 4–6 mm latitudinis maximae. Racemi terminales cum 24–35 floribus, 3.8–12 cm longi, erecti, solitarii, rarifer ramificantes. Tepala angustiae, albae, pallidae viridae vel flavae, 5–6 mm longae, 1–2 mm latae, pauce oblanceolatae, acuminatae, fortifer reflectae cum staminibus extrudantibus. Capsula oblonga, 5–8 mm longa, 4–6 mm lata.

Perennial small herbs. Bulb oblong, 23–40 mm long and 14–21 mm wide. Scape slender, solitary, 286–514 mm tall, its basal peduncle thickness 1–3 mm. Leaves grasslike, distinctly keeled, grayish green, glabrous, with 19.6–34.5 cm maximum leaf length, and 4–6 mm maximum leaf width. Terminal racemes slender, relatively open, with 24–35 flowers. Racemes 3.8–12 cm long, usually solitary, occasionally with 1–3 much shorter lateral ascending racemes. Tepal segments all nearly alike, light greenish to light yellowish-white, linear 5–6 mm long, 1–2 mm wide with a greenish-yellow or light purple central vein. Tepals sharply reflexed fully about ⅔ or more of their length. Stamens exserted, straight, 5–6 mm long; anthers

MADROÑO, Vol. 36, No. 3, pp. 208–216, 1989

light purple becoming brownish-yellow when shedding pollen. Capsule oblong, 5–8 mm long and 4–6 mm wide. Seed wrinkled, black, 4–5 mm in length (Fig. 1).

Paratypes. USA, OR, Curry Co., Collier Creek, 28 Jun 1929, *Leach s.n., 2411, 2412* (ORE); Josephine Co., W of O'Brien, 5 Jul 1939, *Hitchcock and Martin 5166* (CAS, NY, UC); CA, Del Norte Co., Gasquet, Old Gasquet Toll Rd, 5 Jun 1965, *Roderick s.n.* (Jeps) [n=26, n=27, Cave (1970) chromosome voucher *6775*]; Humboldt Co., Willow Creek, Horse Mt., 23 Jul 1979, *Overton and Butler 9473* (HSC); Lake Co., Hulville, 2 Aug 1902, *Heller 6013* (DS, GH, NY, POM); Mendocino Co., Laytonville, Red Mt., Jun 1867, *Bolander s.n.* (DS); Trinity Co., Peanut, Philpot Creek, 13 Jun 1951, *Bacigalupi and Constance 3392* (UC).

Distribution and ecology. Hastingsia serpentinicola is limited to the Klamath Mountains and North Coast Ranges from low to high elevations. It is almost exclusively limited to ultramafic or serpentine rock outcroppings. It occupies open sites in the Klamath Mountains that are moist in the spring but dry out rapidly in the early summer (Fig. 3). It occurs along the edges of wet bogs or in the drier islands within the bog environment. At high elevations (above 1800 m) on exposed serpentine ridges it favors mesic habitats.

Hastingsia alba (Durand) S. Watson, Proc. Amer. Acad. Arts 14: 242, 1879, emend. Becking.—*Schoenolirion album* Durand, J. Acad. Nat. Sci. Philadelphia (Ser. #2) 3:103, 1855. The *Hastingsia alba* holotype material is very fragmentary, consisting only of a few raceme stalks and flowers collected from several individual plants. This "holotype" material was later divided into 3 portions and deposited by Durand himself into three different herbaria (P-DU, PH!, NY!). The Paris, France (P-DU) material was judged to be too fragile for overseas shipment and has not been available (S. Barrier, letter 17 Jun 1987). Because there is no longer a single intact holotype, there are consequently no isotypes (G. Zijlstra ICBN (U), letter 1 Jun 1987; B. C. Stone (PH), letter 12 Aug 1987). The PH material is designated herewith as lectotype because Durand described his "holotype" material during his tenure at the PH herbarium. The P-DU and NY material become isolectotypes. The PH material still contained a single fully intact flower, representing "a portion of the type material collected by H. Pratten in the vicinity of Deer Creek, California, 1851", according to the typed label information.

Perennial herb, often robust. Bulb 26–56 mm long, 17–31 mm wide. Scape robust, 40.4–89 cm tall, basal thickness of the peduncle 3–5 mm. Leaves glaucous green, changing with age to light green,

FIG. 1. *Hastingsia serpentinicola.* a, Fruiting plant; b, flowering plant; c, stamens; d, frontal view of flower; e, pistil; f, part of flowering raceme; g, longitudinal section of flower; h, fruiting raceme; i, part of fruiting raceme; j, cross-section of capsule; k, longitudinal section of capsule; l, seeds; m, longitudinal section of seed. All bar scales = 10 mm.

more fleshy, keeled, 27.8–53 cm long and 7–14 mm wide. Racemes compact, 8–20.3 cm long, densely flowered with 62–75+ flowers, often 2–3 branched, erect and terminal. Perianth segment pure white, sometimes slightly yellowish-white, obtuse, rotate at about half of the tepal length, giving the opened perianth a distinct star-shaped appearance. Basal portion of the perianth bell-shaped when closed. Outer 3 tepals linear, 6–8 mm long and 1 mm wide, ending in a blunt, slightly swollen white tip. Inner 3 tepals ovate, 6–8 mm long and 2 mm wide, often with a crisped margin. Stamens only slightly protruding beyond the perianth, anthers often purplish. Filaments 6–7 mm long. Outer 3 stamens opposite the ovate tepals, usually elongate, and open first; the 3 inner stamens elongate on following days and become almost of equal length to the outer stamens when their anthers dehisce. If the flower has just opened, it appears that for the first days the 3 outer stamens have long filaments whereas the inner stamens have short filaments. Capsule oblong, broadly 3-lobed, 6–9 mm long, and 5–8 mm wide. Seed wrinkled, black, 4–6 mm long (Fig. 2).

Representative specimens. USA, OR, Curry Co., Vulcan Lake, 23 Jul 1978, *Dawn 47* (OSC); Josephine Co., Cave Junction, Illinois River bridge USFS Road 3843, 17 Jun 1982, *Becking 820600* (HSC); CA, Butte Co., Jonesville, 22 Jul 1914, *Hall 9769* (NY); Del Norte Co., Steven Mt., 3 Aug 1980, *Baker 3577* (HSC); Humboldt Co., Hoopa, Mill Creek Lakes, 1 Aug 1979, *Clifton and Griswold 11944* (HSC); Nevada Co., Willow Springs, 26 Jun 1961, *Cruden 1035* (JEPS) [n=26, Cave 1966, 1970]; Plumas Co., N Fork Feather River, Mosquito Creek, 1 Jul 1965, *See s.n.* (JEPS) [n=26, Cave 1970]; Shasta Co., Delta, Sacramento River, 18 Jun 1923, *Bethel s.n.* (CAS); Siskiyou Co., Callahan, French Creek Rd, 12–16 Jun 1948, *Ferris and Lorraine 11730* (ORE, NY, RSA, DS); Tehama Co., Deer Creek Canyon, 17 Jul 1911, *Eggleston 7265* (NY); Trinity Co., Denny, New River-Trinity River confluence, 17 May 1975, *Sullivan 65* (HSC).

Distribution and ecology. Hastingsia alba is not predominantly a species of the Klamath Mountains Geological Province (Ramp and Peterson 1979; Borine 1983; Ferlatte 1974). It has been collected in numerous other locations in the North Coast Ranges and the northern Sierra Nevada. In both situations it occurs on serpentine, on granite, and diorite. It occupies most commonly open rocky seepage areas with a year-round water supply, or bogs or wet meadows, especially at high elevations. Its elevation ranges from 500–2300 m. At high elevations, *H. alba* is often stunted and has smaller bulbs, shorter scapes, and shorter and narrower leaves. The other floral and capsule distinctions, however, are retained (Fig. 3).

FIG. 2. *Hastingsia alba*. a, Fruiting plant; b, flowering plant; c, top of flowering raceme; d, longitudinal view of flower; e, longitudinal section of flower; f, cross-section of leaf; g, flowering plant, robust form; h, top of flowering raceme; i, part of fruiting raceme; j, longitudinal section of capsule; k, cross-section of capsule; l, seeds and longitudinal section of seed. All bar scales = 10 mm.

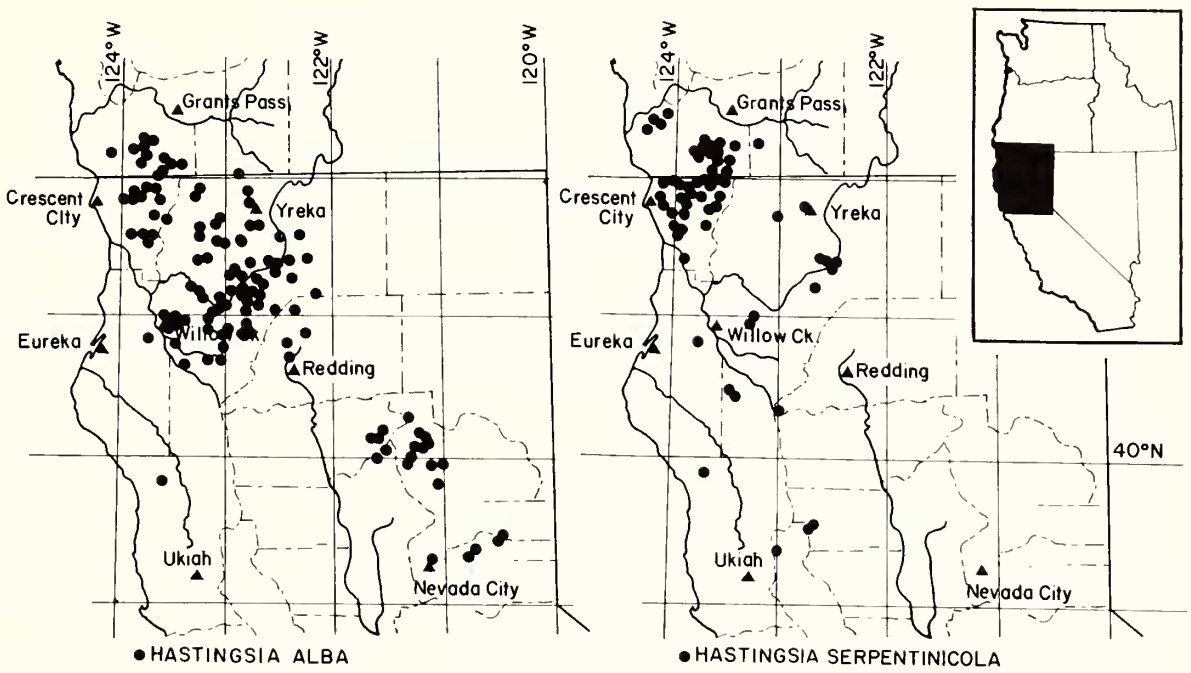

FIG. 3. Distribution of *Hastingsia serpentinicola* and *H. alba.*

COMPARISON OF *HASTINGSIA SERPENTINICOLA* AND *H. ALBA*

Statistical analyses. Comprehensive t-test analyses for unequal variances were applied to the 442 measured specimens selecting the 47 characters for comparison at the individual character level. Twelve most significant characters out of the total 33 significant characters at the 0.01 probability level are identified in Table 1.

Two discriminant analyses (Nie et al. 1975; Dixon et al. 1983) were used independently to classify the 196 herbarium specimens of *Hastingsia serpentinicola* and the 246 specimens of *H. alba.* Thirty-nine quantitative and eight qualitative characters were selected in these tests by the computer programs. All the specimens missing one or more characters of this character set were disqualified from the discriminant analysis. Because of this potential for many unwarranted exclusions, the number of characters had to be selectively limited to increase the number of qualifying cases. Rarely one finds fully developed flowers and mature capsules together on the same individual herbarium specimen or field specimen. Five character groupings were selected using various combinations of bulb, scape, foliage, flower and capsule characters (Table 2). The segregations into the two species were supported by both computer programs in all the character groupings tested (canonical r% = 0.824–0.984, 86–100% correct classification).

Foliage and bulb characters of *Hastingsia alba* performed the poorest among herbarium specimens when either discriminant program was applied. Collectors tend to choose small individuals to

TABLE 1. DISTINCTIONS BETWEEN *HASTINGSIA SERPENTINICOLA* AND *H. ALBA*. All characters listed had significant differences at the 0.01 probability level by t-test analysis. Leaf width was measured selectively on 2–3 undamaged leaves at about the middle of the leaf length to establish the maximum and minimum dimension. "Raceme open" length was measured from the top of the terminal raceme to the lowest lateral raceme branch or the lowest flower in the terminal raceme. "Raceme dense" length was measured from the top of the terminal raceme to where the interspatial distances between the flower pedicels exceeded the length of the perianth. Density of flowers counted the numbers per 5 cm length of the terminal raceme and expressed this count per 10 cm raceme length. The densest (top most portion) and the least sparse (basal portion) raceme portions were selected for counting the maximum/minimum range of flower density respectively. The number of cases involved is indicated in parentheses.

	H. serpentinicola	*H. alba*
Bulb length	23.2–40.2 mm (150)	26.3–55.9 mm (164)
Bulb diameter	13.5–21.1 mm (150)	17.3–31.3 mm (164)
Scape length	28.6–51.4 cm (196)	40.4–89.0 cm (237)
Leaf length max.	19.6–34.5 cm (194)	27.8–52.9 mm (241)
Leaf width max.	3.5–5.7 mm (194)	7.4–13.6 mm (241)
Tepal length max.	4.9–6.3 mm (189)	5.5–7.5 mm (213)
Tepal width max.	0.9–1.9 mm (189)	1.7–2.3 mm (213)
Raceme open length	4.5–26.7 cm (192)	13.7–39.8 cm (243)
Raceme dense length	3.8–12.0 cm (192)	8.0–20.3 mm (243)
Flower density max.	28.3–48.5 mm (160)	38.6–63.6 mm (207)
Flower density min.	21.7–41.9 mm (131)	32.4–56.2 mm (205)
Capsule length max.	4.7–7.5 mm (061)	5.7–9.3 mm (098)
Capsule width max.	3.6–6.0 mm (061)	4.5–7.7 mm (098)

press and often remove the dead and shriveled black basal leaves. Extraction of bulbs at depths of 25–45 cm often leaves the tunica in the soil. Only older specimens develop the typical tunica, whereas younger and smaller specimens do not. The bulbs are often cut or squashed making it most difficult to obtain representative measurements. Capsules are often immature. Only fully matured capsules with black seeds are dimensionally representative. In segregations based upon herbarium specimens, *H. serpentinicola* was classified more consistently than *H. alba* (85–100% correct classification). In mature and fresh specimens, however, such misclassifications were rarely encountered.

Distinction between species. In past treatments (Jepson 1921, 1936; Abrams 1923; Mason 1957; Munz 1959; Peck 1961; Ferlatte 1974) *Hastingsia serpentinicola* has not been segregated from *H. alba.* Stature and size differences were attributed to harsh environmental conditions. However, Roderick, in 1965, annotated his collections of *H. serpentinicola* (JEPS) as distinct from *H. alba.* He further noted that plants now attributed to *H. serpentinicola* occur "almost always on serpentine on well-drained soil never in a bog".

Both *Hastingsia* species were cultivated for many years in the Botanical Garden at UC Berkeley, CA. Growing both in the same

TABLE 2. DISCRIMINANT ANALYSES USING 246 SPECIMENS OF *HASTINGSIA ALBA* AND 196 SPECIMENS OF *H. SERPENTINICOLA*. The first two lines per category represent the SPSS90 program results, the third line the BMDP83 results, using identical data sets. *1)* # char = the number of characters selected by the program for classification into the grouping. *2)* (#*) = the number of most significant characters selected within the character grouping for the final classification function. *3)* # cases = the number of cases selected with complete character sets within the grouping. *4)* canon. r% = canonical correlation coefficient of the final classification function. *5) H. a.* and *H. s.* = *Hastingsia alba* and *H. serpentinicola,* respectively. *6)* % class (#) = percent of correct classification (number of cases involved). *7)* J = Jackknife classification using Mahalanobis D^2 (BMDP83). *8)* W = Wilk's Lambda (SPSS90) classification.

Character groupings	[1]# char, [2](#*)	[3]# cases	[4]canon. r%		Percent correctly classified [5]*H. a.* [6]% class (#)	*H. s.* % class (#)	Total % class
Bulb, scape, foliage	10 (2*)	298	0.824	[7]J:	86.3 (153)	100.0 (145)	93.0
					86.3 (153)	100.0 (145)	93.0
	10 (4*)	298	0.824	[8]W:	87.9 (224)	100.0 (194)	93.5
Foliage, scape	8 (4*)	411	0.824		87.8 (222)	100.0 (189)	93.2
				J:	87.4 (222)	100.0 (189)	93.2
	8 (4*)	411	0.824	W:	87.9 (224)	100.0 (194)	93.5
Foliage, scape, flower	26 (3*)	232	0.984		99.3 (135)	99.0 (097)	99.1
				J:	99.3 (135)	99.0 (097)	99.1
	26 (7*)	232	0.985	W:	97.9 (188)	84.9 (179)	91.6
Foliage, scape, capsule	14 (3*)	92	0.873		95.0 (060)	100.0 (032)	96.7
				J:	95.0 (060)	100.0 (032)	96.7
	14 (5*)	92	0.885	W:	98.3 (064)	100.0 (032)	98.9
Bulb, scape, foliage, flower, capsule	47 (6*)	30	0.972		100.0 (018)	100.0 (012)	100.0
				J:	100.0 (018)	100.0 (012)	100.0
	47 (18*)	37	0.999	W:	95.5 (022)	86.7 (015)	91.9

rich garden soil, the cultivated specimens produced flowers and viable seeds (W. Roderick, letter 24 Dec 1985) and retained their distinctive characters, suggesting no environmental influences upon these morphological characters. *Hastingsia serpentinicola* did not flourish well, however, in Berkeley, with its mild winters and hot dry summers. Herbarium specimens of these cultivated *Hastingsia* plants served as voucher specimens for pollen collection and chromosome counting (Cave 1966, 1970).

ACKNOWLEDGMENTS

Curators of the various herbaria (CAS, DAV, DS, GH, HSC, JEPS, NY, ORE, OSC, PH, PUA, ROPA, RSA, SOC, UC) are acknowledged for their hospitality during visits and loan of specimens. Acknowledged are the constructive comments of Dr. F. Raymond Fosberg (NAT), Dr. M. G. McLeod, Dr. Robert Peet (NC), Dr. Wm. A. Weber (CO), 9 anonymous reviewers and 2 editors.

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(Resubmitted 12 Sep 1988; revision accepted 9 Mar 1989.)